

## FEATURES

- **Guaranteed**  $\pm 4\text{mV}$  Initial Accuracy LT1004-1.2
- **Guaranteed**  $\pm 20\text{mV}$  Accuracy LT1004-2.5
- **Guaranteed**  $10\mu\text{A}$  Operating Current
- **Guaranteed** Temperature Performance
- Operates up to  $20\text{mA}$
- Very Low Dynamic Impedance

## APPLICATIONS

- Portable Meter References
- Portable Test Instruments
- Battery-Operated Systems
- Current Loop Instrumentation

## DESCRIPTION

The LT<sup>®</sup>1004 micropower voltage reference is a 2-terminal bandgap reference diode designed to provide high accuracy and excellent temperature characteristics at very low operating currents. Optimization of the key parameters in the design, processing and testing of the device results in accuracy specifications previously attainable only with selected units. Below is a distribution plot of reference voltage for a typical lot of LT1004-1.2. Virtually all of the units fall well within the prescribed limits of  $\pm 4\text{mV}$ .

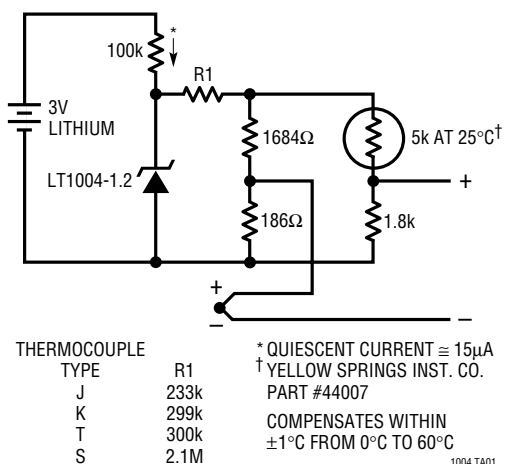
The LT1004 is a pin-for-pin replacement for the LM185/LM385 series of references with improved accuracy specifications. More important, the LT1004 is an attractive device for use in systems where accuracy was previously obtained at the expense of power consumption and trimming.

For a low drift micropower reference with guaranteed temperature coefficient, see the LT1034 data sheet.

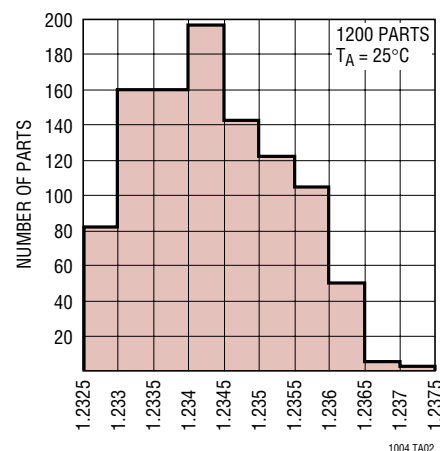
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## TYPICAL APPLICATION

### Micropower Cold Junction Compensation for Thermocouples



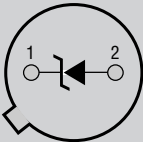
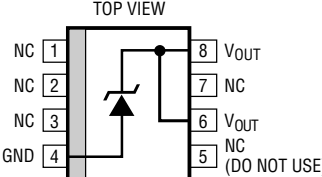
**Typical Distribution of  
Reference Voltage (LT1004-1.2)**



## ABSOLUTE MAXIMUM RATINGS (Note 1)

|                                            |                |                                   |                |
|--------------------------------------------|----------------|-----------------------------------|----------------|
| Reverse Breakdown Current .....            | 30mA           | Operating Temperature Range       |                |
| Forward Current .....                      | 10mA           | LT1004M ( <b>OBSOLETE</b> ) ..... | –55°C to 125°C |
| Storage Temperature Range .....            | –65°C to 150°C | LT1004I .....                     | –40°C to 85°C  |
| Lead Temperature (Soldering, 10 sec) ..... | 300°C          | LT1004C .....                     | 0°C to 70°C    |

## PACKAGE/ORDER INFORMATION

|                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                 |                                |                                                                                                                                                                                                                                                       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>BOTTOM VIEW</p>  <p>H PACKAGE<br/>2-LEAD TO-46 METAL CAN</p> <p><math>T_{JMAX} = 150^{\circ}\text{C}</math>, <math>\theta_{JA} = 440^{\circ}\text{C/W}</math>, <math>\theta_{JC} = 80^{\circ}\text{C/W}</math></p> | <p>TOP VIEW</p>  <p>S8 PACKAGE<br/>8-LEAD PLASTIC SO</p> <p><math>T_{JMAX} = 100^{\circ}\text{C}</math>, <math>\theta_{JA} = 150^{\circ}\text{C/W}</math></p> |                                | <p>BOTTOM VIEW</p>  <p>Z PACKAGE<br/>3-LEAD PLASTIC TO-92</p> <p><math>T_{JMAX} = 100^{\circ}\text{C}</math>, <math>\theta_{JA} = 160^{\circ}\text{C/W}</math></p> |
| ORDER PART<br>NUMBER                                                                                                                                                                                                                                                                                   | ORDER PART<br>NUMBER                                                                                                                                                                                                                            | S8 PART<br>MARKING             | ORDER PART<br>NUMBER                                                                                                                                                                                                                                  |
| LT1004MH-1.2    LT1004CH-1.2<br>LT1004MH-2.5    LT1004CH-2.5<br><b>OBSOLETE PACKAGE</b><br>Consider the SO-8 or Z Packages for Alternate Source                                                                                                                                                        | LT1004CS8-1.2<br>LT1004CS8-2.5<br>LT1004IS8-1.2<br>LT1004IS8-2.5                                                                                                                                                                                | 0412<br>0425<br>0412I<br>0425I | LT1004CZ-1.2<br>LT1004CZ-2.5<br>LT1004IZ-1.2<br>LT1004IZ-2.5                                                                                                                                                                                          |

Consult LTC Marketing for parts specified with wider operating temperature ranges.

## ELECTRICAL CHARACTERISTICS The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at $T_A = 25^{\circ}\text{C}$ . (Note 2)

| SYMBOL                                      | PARAMETER                                     | CONDITIONS                                                                  | LT1004-1.2 |       |       | LT1004-2.5 |       |       | UNITS                   |
|---------------------------------------------|-----------------------------------------------|-----------------------------------------------------------------------------|------------|-------|-------|------------|-------|-------|-------------------------|
|                                             |                                               |                                                                             | MIN        | TYP   | MAX   | MIN        | TYP   | MAX   |                         |
| $V_Z$                                       | Reverse Breakdown Voltage                     | $I_R = 100\mu\text{A}$                                                      | 1.231      | 1.235 | 1.239 | 2.480      | 2.500 | 2.520 | V                       |
|                                             |                                               | LT1004M: $-55^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$ ●          | 1.220      | 1.230 | 1.245 | 2.460      | 2.500 | 2.535 | V                       |
|                                             |                                               | LT1004C: $0^{\circ}\text{C} \leq T_A \leq 70^{\circ}\text{C}$ ●             | 1.225      | 1.235 | 1.245 | 2.470      | 2.500 | 2.530 | V                       |
|                                             |                                               | LT1004I: $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ ●           | 1.220      | 1.230 | 1.245 | 2.460      | 2.500 | 2.530 | V                       |
| $\frac{\Delta V_Z}{\Delta T_{\text{Temp}}}$ | Average Temperature Coefficient               | $I_{\text{MIN}} \leq I_R \leq 20\text{mA}$ (Note 3)                         |            | 20    |       | 20         |       |       | ppm/ $^{\circ}\text{C}$ |
| $I_{\text{MIN}}$                            | Minimum Operating Current                     |                                                                             | ●          | 8     | 10    | 12         | 20    |       | $\mu\text{A}$           |
| $\frac{\Delta V_Z}{\Delta I_R}$             | Reverse Breakdown Voltage Change with Current | $I_{\text{MIN}} \leq I_R \leq 1\text{mA}$                                   | ●          |       | 1.0   |            |       | 1.0   | mV                      |
|                                             |                                               |                                                                             | ●          |       | 1.5   |            |       | 1.5   | mV                      |
|                                             |                                               | $1\text{mA} \leq I_R \leq 20\text{mA}$                                      | ●          |       | 10    |            |       | 10    | mV                      |
| $r_Z$                                       | Reverse Dynamic Impedance                     | $I_R = 100\mu\text{A}$                                                      | ●          | 0.2   | 0.6   | 0.2        | 0.6   |       | $\Omega$                |
|                                             |                                               |                                                                             | ●          |       | 1.5   |            | 1.5   |       | $\Omega$                |
| $e_n$                                       | Wide Band Noise (RMS)                         | $I_R = 100\mu\text{A}$ , $10\text{Hz} \leq f \leq 10\text{kHz}$             |            | 60    |       | 120        |       |       | $\mu\text{V}$           |
| $\frac{\Delta V_Z}{\Delta T_{\text{Time}}}$ | Long Term Stability                           | $I_R = 100\mu\text{A}$ , $T_A = 25^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$ |            | 20    |       | 20         |       |       | ppm/kHr                 |

**Note 1:** Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

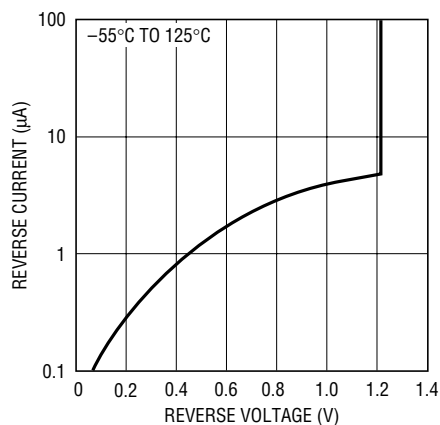
**Note 2:** All specifications are for  $T_A = 25^{\circ}\text{C}$  unless otherwise noted.

**Note 3:** Selected devices with guaranteed maximum temperature coefficient are available upon request.

For MIL-STD components, please refer to LTC 883C data sheet for test listing and parameters.

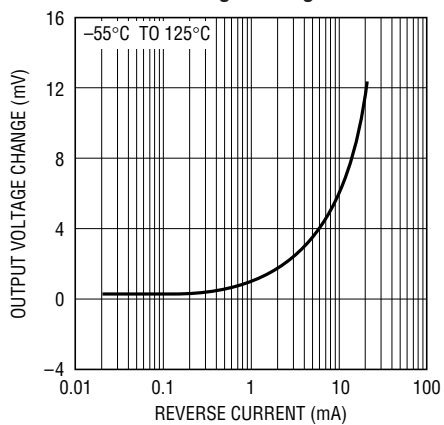
# TYPICAL PERFORMANCE CHARACTERISTICS (1.2V)

Reverse Characteristics



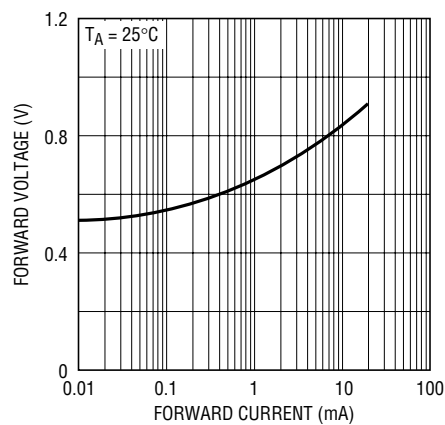
1004 G01

Reverse Voltage Change



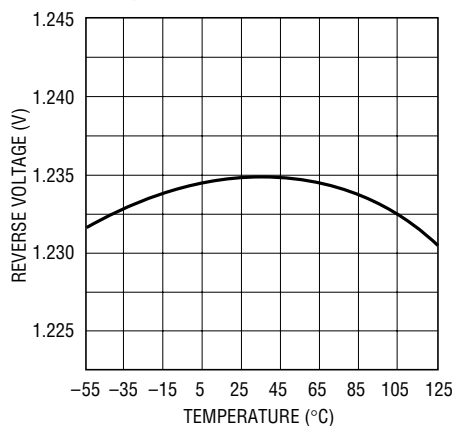
1004 G02

Forward Characteristics



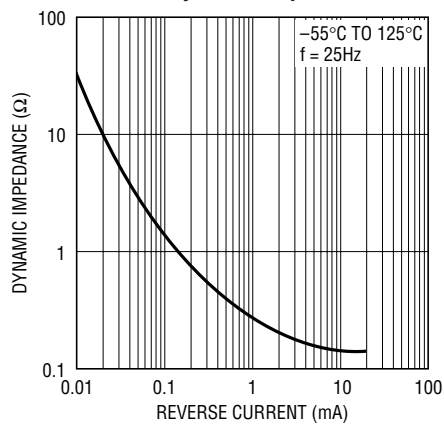
1004 G11

Temperature Drift



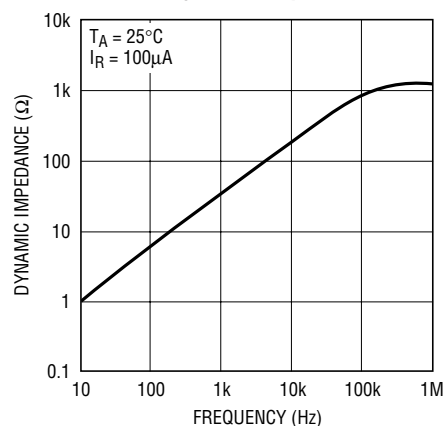
1004 G04

Reverse Dynamic Impedance



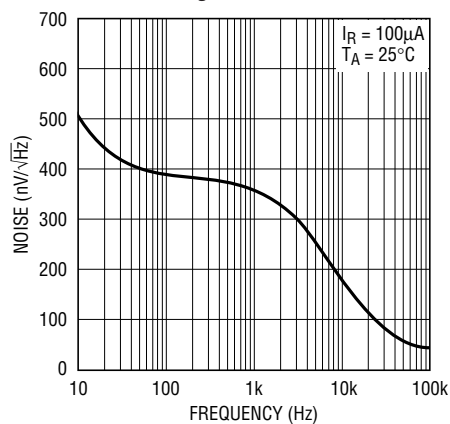
1004 G05

Reverse Dynamic Impedance



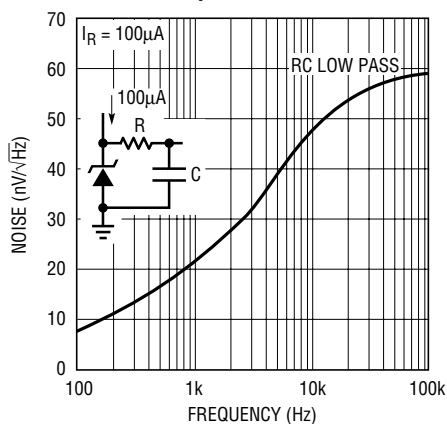
1004 G06

Noise Voltage



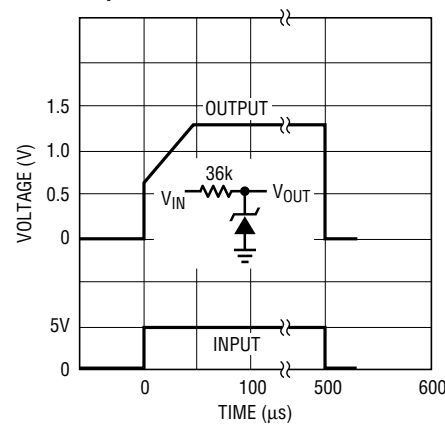
1004 G07

Filtered Output Noise



1004 G08

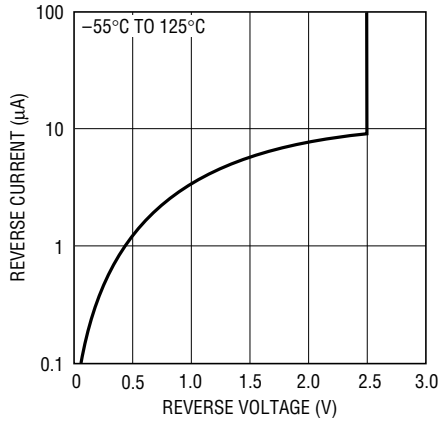
Response Time



1004 G09

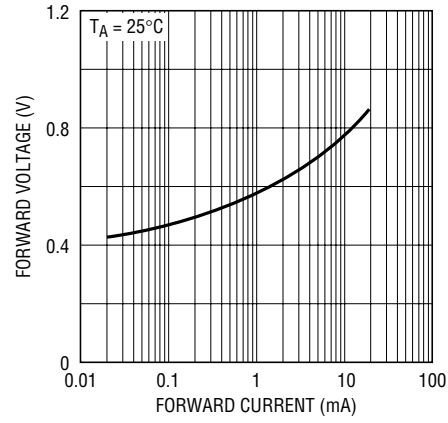
# TYPICAL PERFORMANCE CHARACTERISTICS (2.5V)

Reverse Characteristics



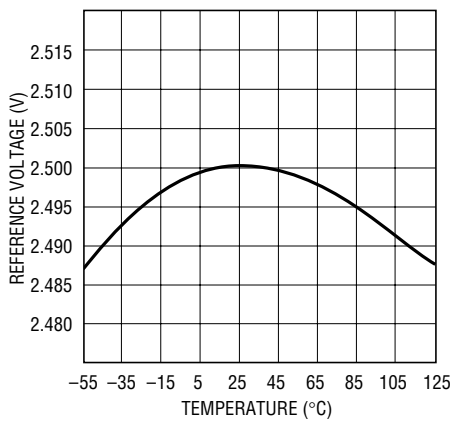
1004 G10

Forward Characteristics



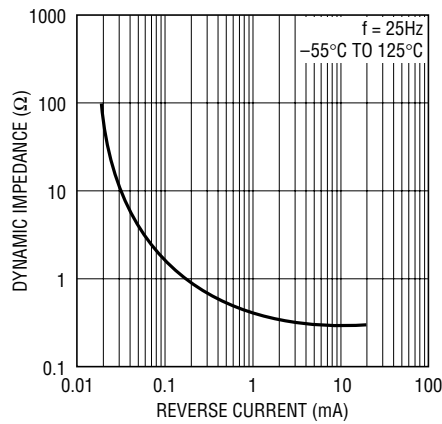
1004 G11

Temperature Drift



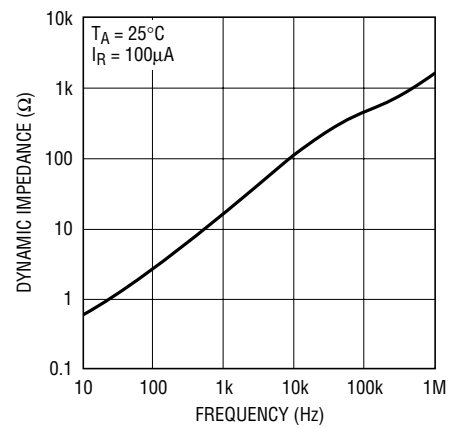
1004 G12

Reverse Dynamic Impedance



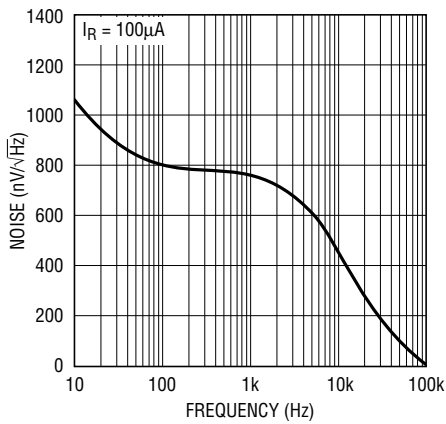
1004 G13

Reverse Dynamic Impedance



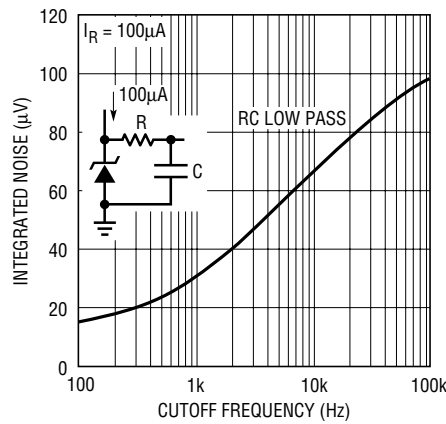
1004 G14

Noise Voltage



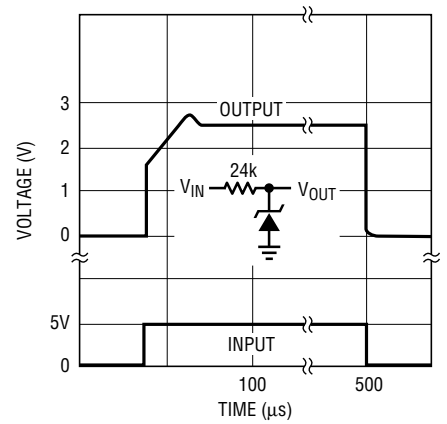
1004 G15

Filtered Output Noise



1004 G16

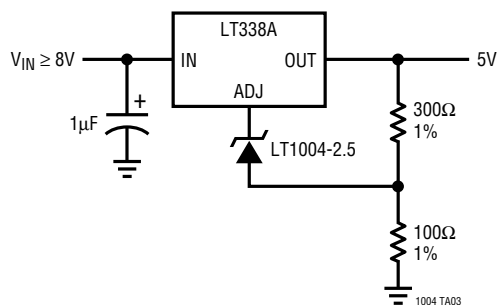
Reponse Time



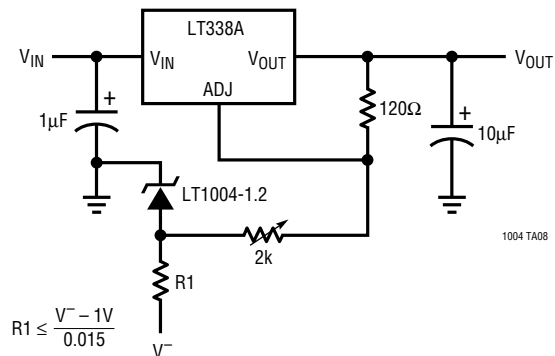
1004 G17

# TYPICAL APPLICATIONS

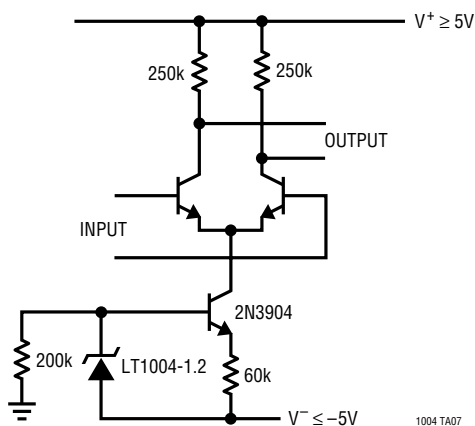
## High Stability 5V Regulator



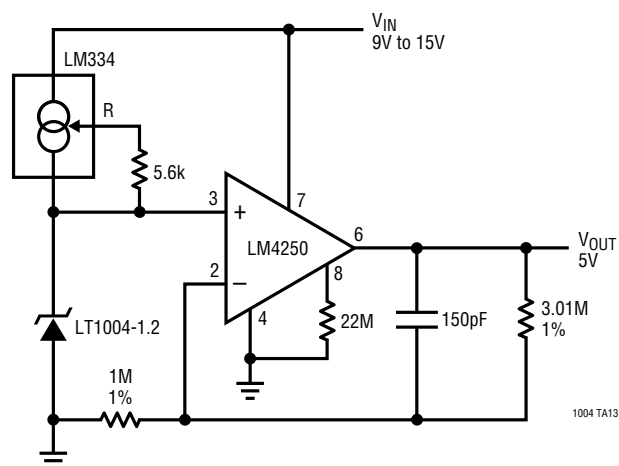
## Variable Output Supply



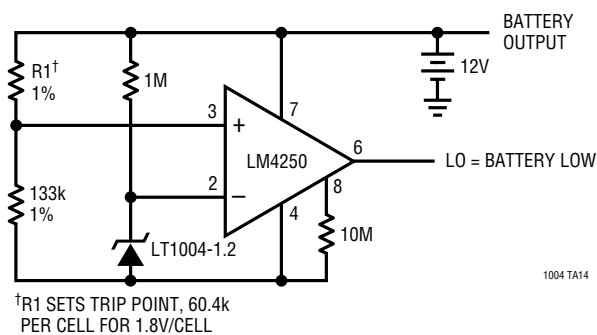
## Constant Gain Amplifier Over Temperature



## Micropower 5V Reference

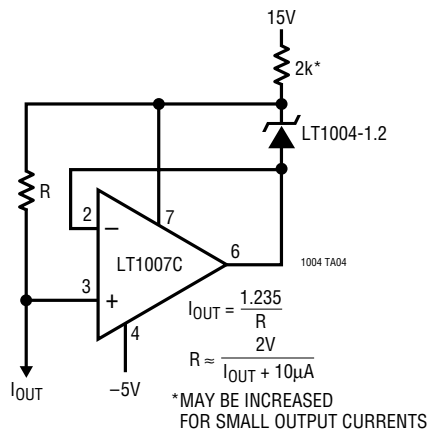


## Lead Acid Low-Battery Detector



<sup>†</sup>R1 SETS TRIP POINT, 60.4k PER CELL FOR 1.8V/CELL

## Ground Referenced Current Source



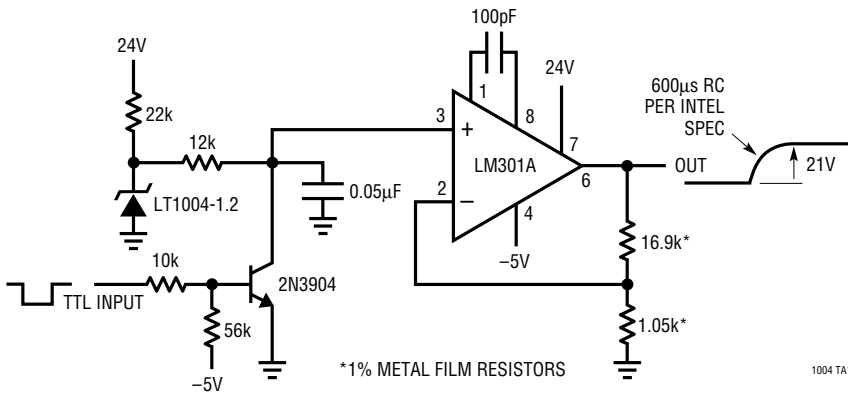
$$I_{OUT} = \frac{1.235}{R}$$

$$R = \frac{2V}{I_{OUT} + 10\mu A}$$

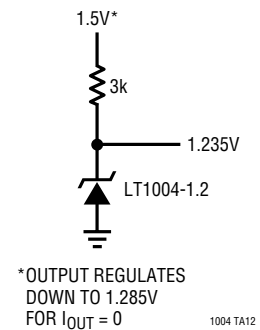
\*MAY BE INCREASED FOR SMALL OUTPUT CURRENTS

## TYPICAL APPLICATIONS

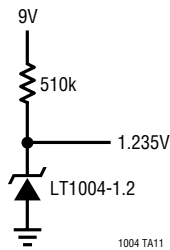
VPP Generator for Eeproms — No Trim Required



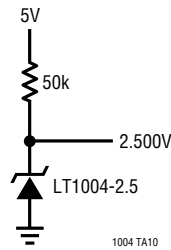
1.2V Reference from 1.5V Battery



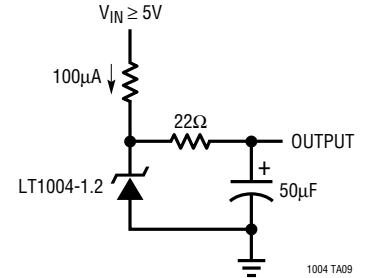
Micropower Reference from 9V Battery



2.5V Reference

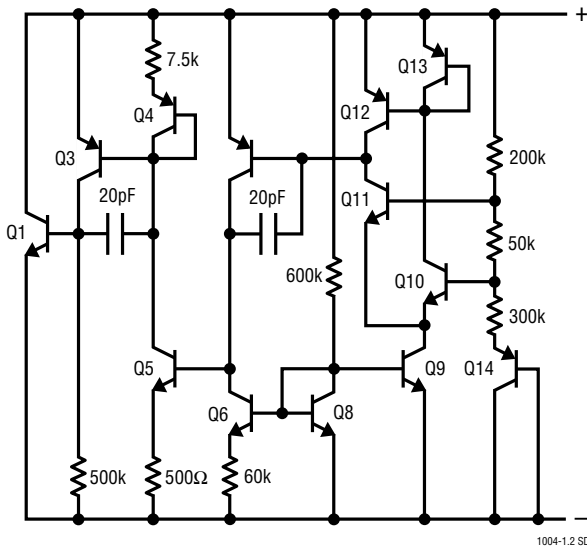


Low Noise Reference

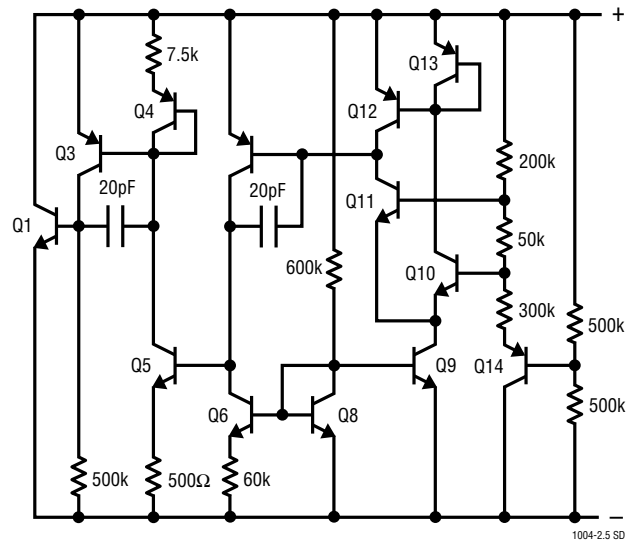


## SCHEMATIC DIAGRAMS

LT1004-1.2

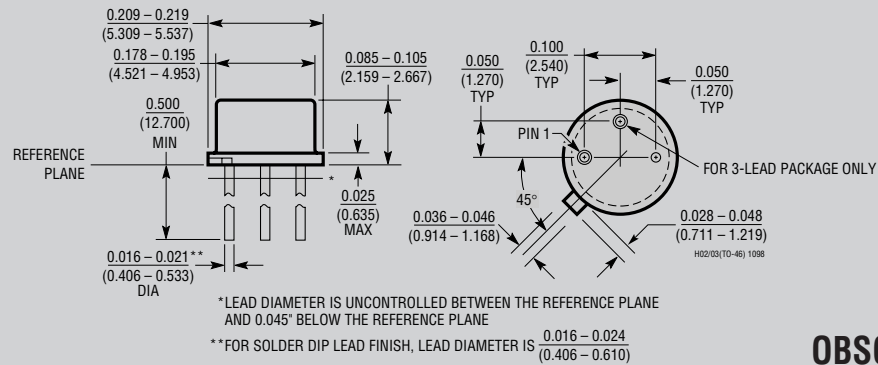


LT1004-2.5



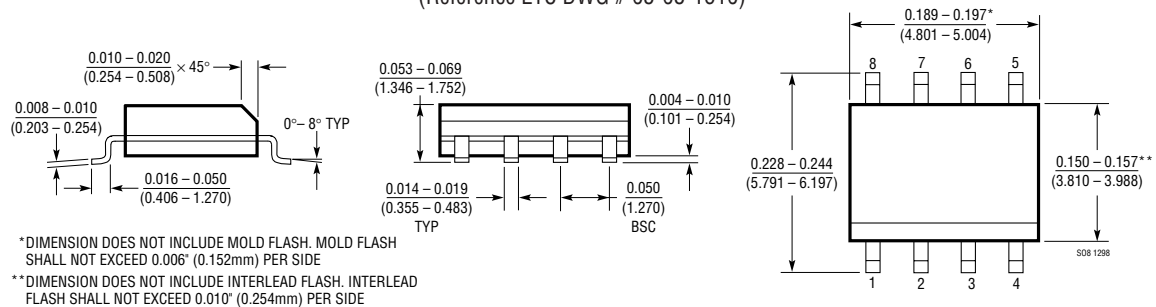
## PACKAGE DESCRIPTION

### H Package 2-Lead and 3-Lead TO-46 Metal Can (Reference LTC DWG # 05-08-1340)

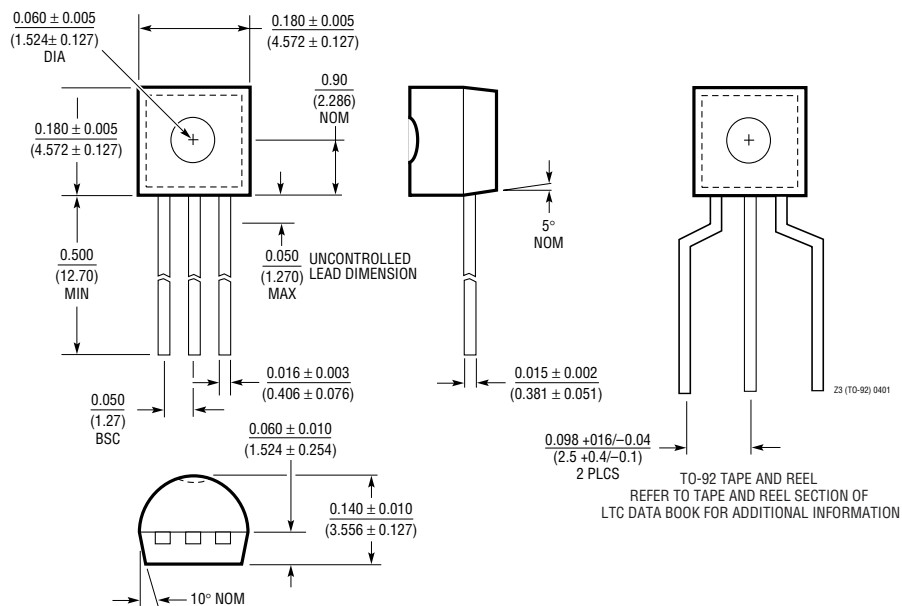


**OBsolete PACKAGE**

### S8 Package 8-Lead Plastic Small Outline (Narrow .150 Inch) (Reference LTC DWG # 05-08-1610)

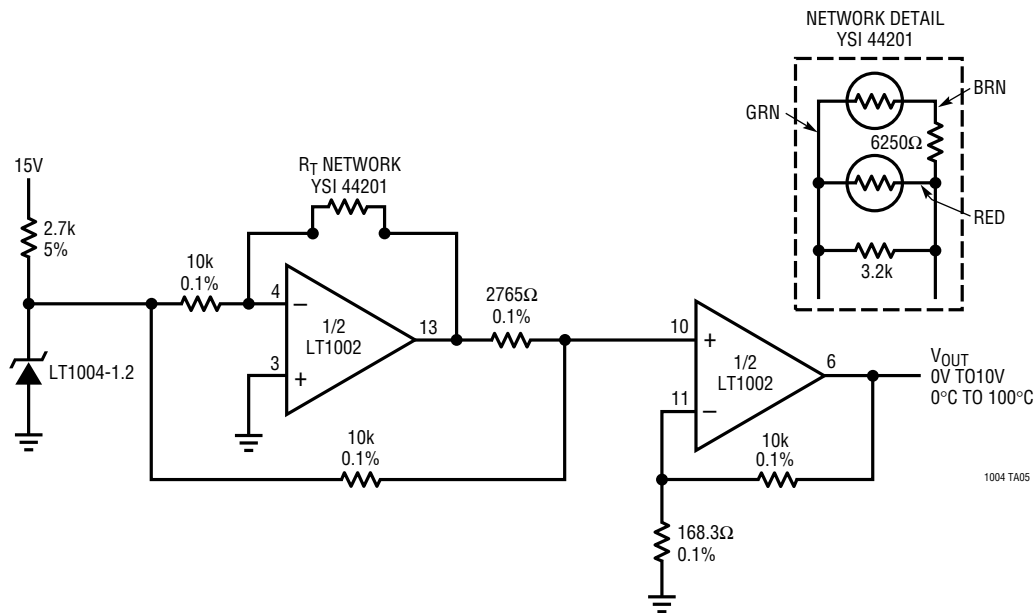


### Z Package 3-Lead Plastic TO-92 (Similar to TO-226) (Reference LTC DWG # 05-08-1410)

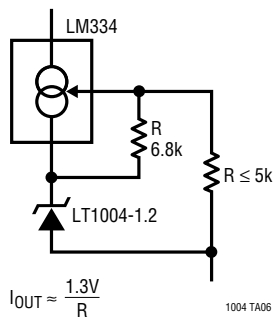


TYPICAL APPLICATIONS

0°C to 100°C Linear Output Thermometer



Low Temperature Coefficient  
2-Terminal Current Source



RELATED PARTS

| PART NUMBER  | DESCRIPTION                                  | COMMENTS                                                               |
|--------------|----------------------------------------------|------------------------------------------------------------------------|
| LT1634       | Micropower Precision Shunt Reference         | 10µA Operating Current, 10ppm/°C Maximum Drift, 0.05% Initial Accuracy |
| LT1460S3-2.5 | Micropower Series Reference in SOT-23        | 100µA Operating Current, 20ppm/°C Maximum Drift, 0.2% Initial Accuracy |
| LT1790       | Precision Micropower LDO Reference in SOT-23 | 10ppm/°C Max Drift, 0.05% Initial Accuracy                             |